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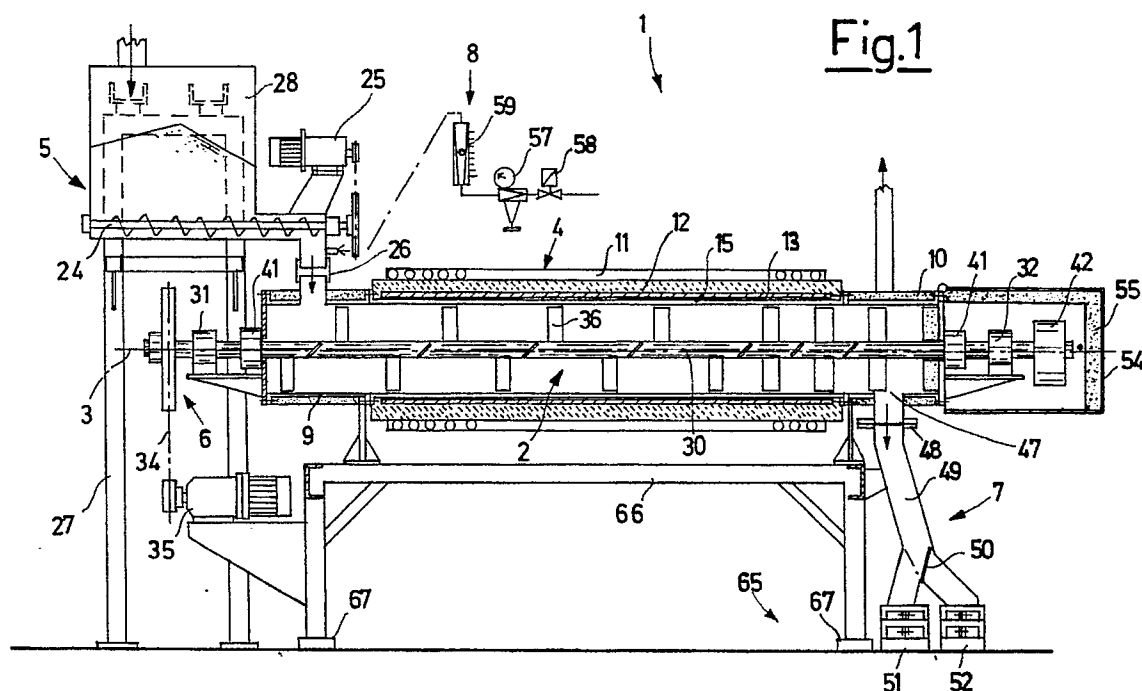
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(54) **Kiln in particular for producing litharge by means of the calcination of massicot.**

(57) The kiln (1) for producing litharge has a thermally insulated tubular body (2) containing, throughout its length, a shaft (3u) with paddles acting as an auger. The tubular body (2) is coaxial with an induction coil (11), which heats it. The raw material in powder form (i.e., the massicot) is charged at a first

head (9) of the tubular body (2) and is moved forwards by the paddle shaft (30), until it reaches the second head (10), opposite to the first one (9). During the translation the material (massicot) is heated and is oxidated, being converted into litharge.



EP 0 406 954 A1

KILN IN PARTICULAR FOR PRODUCING LITHARGE BY MEANS OF THE CALCINATION OF MASSICOT

The present invention is concerned with a calcination kiln, in particular for producing litharge by means of the calcination of massicot.

Litharge, which is a chemical product whose formula is PbO , is used in several industrial sectors and one among the most common methods for producing it is the one which resorts to the calcination of massicot, which is a mixture of lead oxide and metal lead and has the chemical formula $PbO + Pb$.

The presently used kilns comprise a plurality of tubes, lapped by the flue gases generated by the combustion, e.g., of methane gas, and so connected as to run along an essentially "S"-shaped trajectory.

Massicot, charged to an end of the "S"-shaped path leaves it (after being heated and oxidated), transformed into litharge, at the opposite end.

The movement of advancement of the material takes place in countercurrent to the flue gases generated by combustion.

The kilns known from the prior art show several drawbacks, the main of which are briefly described in the following.

(a) only a portion of the kiln, and more precisely about half thereof, is active as regards the conversion of massicot into litharge; the residual portion of the kiln performs the function of recovering the thermal energy produced by the kiln, by pre-heating massicot, which will be subsequently transformed into litharge. As a consequence, the dimensions of the kiln are very large relatively to its throughput.

(b) Owing to its large dimensions, the kiln reaches its steady-state operating temperature with poor precision in the various regions; in fact, the value of temperature inside the kiln is influenced by many factors interacting with one another, such as, e.g., the temperature of the combustion chamber, of the burner, the flow rate of the air stream injected into the kiln, and the heat dispersions. Controlling such factors becomes more and more difficult as the dimensions of the kiln increase.

(c) The need for providing at least one combustion chamber and for reducing energy consumption by recovering a portion of the generated heat by pre-heating massicot, causes a further increase in kiln dimensions.

(d) The large surface-area of the external surfaces of the combustion chamber cause considerably heat losses towards the external environment, to which the heat losses caused by the stack add up.

(e) The products of the combustion submit the

tubes lapped by the flue gases to considerable stresses of chemical and thermal nature, with frequent interventions for inspection and maintenance being necessary.

(f) Also the lining structure of refractory bricks directly invested by the flames and/or highly corrosive gases, generated by the combustion, requires frequent interventions for inspection and maintenance.

(g) The possible perforation of, or formation of crevices in, one or more tubes, causes the coming of the product contained in said tube(s) into direct contact with the flame, with the consequent dispersion of lead oxide into the surrounding environment, through the stack, with evident ecological damages.

The purpose of the present invention is of simultaneously obviating all of the above reminded drawbacks.

Such purposes are achieved by a kiln for producing litharge by means of the calcination of massicot advancing inside the interior of the same kiln under the action of screw conveyor means, characterized in that it comprises one single tubular structure destined to contain massicot advancing between a first end and a second end, means for charging massicot installed at the first end of the tubular structure, heating means operating on the basis of the principle of electromagnetic induction, acting along the length of the tubular structure, means for injecting the massicot oxidating gas, and means for discharging massicot transformed into litharge, installed at the second end of the tubular structure.

The invention is illustrated for merely exemplifying, non-limitative purposes, in the schematic figures of the hereto attached drawing tables, wherein:

Figure 1 shows a sectional side view of the kiln according to the present invention;

Figure 2 shows a front view of the kiln;

Figure 3 shows a sectional view of the heating unit;

Figure 4 shows a view of the beating device applied to the shaft of the kiln;

Figure 5 shows a view of the means for shifting the shaft with the paddles;

Figure 6 shows a view of the out-of alignment position of the shaft with paddles, relatively to the tubular structure of the kiln which contains it.

Referring to the above figures, the kiln according to the present invention, generally indicated with the reference numeral 1, is destined in particular to the production of litharge by massicot calcination.

The kiln essentially comprises one single tubular body 2 with major axis 3 (i.e., "the axis of the kiln"), a heating unit 4, means 5 for feeding the raw material to the kiln, means 6 of screw conveyor type for translating the processed material inside the interior of the tubular body, means 7 for discharging the material, means 8 for feeding the oxidating air and means 5 for controlling the de-

pressure inside the kiln.

The kiln 1 can be additionally equipped with means for weighing it, which are essential for it to correctly operate.

The tubular body 2 comprises a stainless-steel tube provided with a first head 9 and a second head 10. Said first and second heads are thermally insulated and are respectively associated with the means 5 for feeding the material to the kiln and with the means 7 for discharging the treated material from the kiln.

The tubular body 2 is coaxially contained inside the heating unit 4, which comprises, listed from outside inwards, an induction coil 11, a layer of insulating refractory material 12 and a tube of ferromagnetic material 13.

The induction coil 11 is constituted by a plurality of elements; in the herein illustrated case, said induction coil is constituted by three elements 11A, 11B and 11C, having different numbers of turns and hence capable of offering different heating powers. Also the tube of ferromagnetic material 13 is constituted by a plurality of elements 13A, 13B and 13C, linked by joints 14.

The coil elements 11A, 11B and 11C heat, by induction, the respective elements 13A, 13b and 13C which in their turn transmit heat to the tubular body 2, which is made from an inoxidizable material in order to be capable of withstanding the aggressivity of the material in course of transformation inside its interior.

In order to prevent the corrosion of the tube 13 and, obviously, of the elements 13A, 13B and 13C which compose it, between said tube 13 and the tubular body 2 an air space 15 is provided, inside which an inert gas, such as, e.g., nitrogen, is injected. For that purpose, a nitrogen feed hose 16 and a nitrogen discharge hose 17 are respectively provided at both ends of the heating unit and in correspondence of sealing means comprising a sealing band of fiberglass-reinforced silicone resin. In that way, nitrogen can be renewed whenever necessary.

The layer of insulating refractory material 12 comprises, listed from outside inwards, spacer beams 19, a coating 20 of fiberglass-reinforced polyester resin, a plurality of layers 21 of a material known on the market under the trade name "Microterm" (in the herein exemplified case two of such layers are provided), a wrapping made from a

fiberglass or asbestos 22 ribbon, a plurality of layers or ceramic fibre 23 (in the herein exemplified case two of such layers are provided). "Microterm" is obtained by filling bags of fiberglass cloth with titanium and zirconium oxides, and is endowed with high characteristics of heat insulation.

The use of "Microterm" as the heat-insulating material, rather than other materials, made it possible, thanks to the high-level characteristics of this material, the thickness of the layer of insulating refractory material 12 to be considerably reduced, thus facilitating the realization of the induction coil 22.

The means 5 for feeding the raw material to the kiln comprise a feed hopper 28, a metering screw feeder 24 driven by a relevant ratiomotor 25, and a support structure 27. The metering screw feeder draws the material from the bottom of the hopper 28 and discharges it directly to the first head 9 which is purposely provided with a flexible coupling 26.

Between said support structure 27 and said feed hopper 28 load cells 29 are installed, which detect the weight of the hopper 28. The detected data is sent to a circuit which determines the decrease in the weight of the metering screw feeder during the unit time, compares said decrease to the optimum preset feed rate and then, if necessary, corrects the revolution speed of the auger of the metering screw feeder 24 by acting on the ratiomotor 25 such as to adjust -- if necessary -- said raw material feed rate back within the preset range for its values.

The conveyor screw means 24 for translating the material inside the tubular body 6 substantially comprise a shaft 30 with paddles, the axis of which shaft is the same major axis 3 of the kiln, a chain transmission 34 and a relevant motor 35. The paddles 36 installed on the shaft 30 are so arranged as to form a simple screw -- or auger -- in the region closest to the first head 9 and in the intermediate region between the first head 9 and the second head 10, whilst in the region closest to the second head 10, the screw or auger formed by the paddles 36 is a double one.

The shaft 30 is respectively supported at its first and second ends respectively by a first bearing 31 and a second bearing 32; such bearings can be shifted perpendicularly to the axis 3 of the kiln.

Referring in particular to Figures 5 and 6, the axis 3 can be regarded as defined by the intersection of a vertical plane 37 with a horizontal plane 38.

Such planes define a first, a second, a third and a fourth sector of the kiln 1. A suitable guide plane 39 and screw adjusting means 40 make it possible the distance "d" between the axis of the

kiln and the axis of the shaft 30 with paddles to be adjusted, so that said shaft 30 can be placed, owing to an oblique shift, in the second, or in the fourth sector of the kiln. In fact, experience has demonstrated that an accumulation of the handled material usually occurs in the fourth sector, and therefore the possibility of displacing the shaft 30 and arranging in the fourth sector makes it possible such a material to be removed.

In order to make it possible the material to be removed without moving the shaft to an out-of-alignment position, it is not possible to think of simply dimensioning the height of the paddles 36 in such a way that said paddles will skim all of the internal surface of the tubular body 2, running with their ends as close as possible to said surface, because in that case the bending the tubular body 2 undergoes to the mechanical and thermal stresses deriving from the material to be processed, would cause the seizure of the means which convey the material inside the kiln. In practice, the upper end of some paddles would get seized against the internal surface of the tubular body 2. Any anomalies in kiln operation can be anyway detected as soon as they arise, e.g., by measuring the current absorbed by the motor 35 and using such a value as an index of risk of seizure of the conveyor screw means 6. The shaft 30 is associated with stuffing boxes 41 lubricated with a high-temperature grease in order to prevent the material contained inside the tubular body 2, which material is highly pollutant, to escape to the surrounding environment.

Owing to the nature of the material to be processed, and to the structure of the shaft 30 with paddles, it frequently occurs that the material adheres to an exceptionally high extent to the same shaft 30, overcharging it.

In order to prevent any undesired accumulations of material, beating means 42 have been provided (see Figure 4) installed, e.g., at the second end of the shaft 30.

Said beating means 42 comprise a plurality of hammers 43, e.g., of pneumatic type, so positioned that the blow dealt by each hammer to the shaft 30 is compensated for by the blow(s) dealt by the other hammer(s).

In the herein exemplified case, the hammers are three, of pneumatic type, and with axes at 120° to each other, and are capable of reaching beating frequencies of up to 1000 blows per minute. The blowing frequency can be adjusted at the desired value by acting on a valve 53. The blow dealt to the shaft 30 by each pneumatic hammer 43 is compensated for by the blow dealt by the other two hammers, with damages to the bearing 31 and 32 being thus avoided; however, the struck shaft 30 vibrates, causing the material

which possibly overcharges it, to get detached. The pneumatic hammers are constrained to a triangular support structure 44 which comprises trueing rings 45, and all of them are fed simultaneously thanks to one single pneumatic duct 46.

The considerable volume of noise generated by the pneumatic hammers 43 is deadened by a case 54 provided with an internal lining 55 of soundproofing material.

The means for discharging the material 7 comprise an opening 47 placed in correspondente of the second head 10, a sliding coupling flange 48, and a duct 49 which branches into two ducts in correspondence of a switching gate 50.

The two ducts arising from the branching of the duct 49 respectively end over a first conveyor tape 51 and a second conveyor tape 52. The switching gate 50 makes it possible the exiting stream of material (litharge) to be addressed as a function of the quality level, i.e., of the purity level reached by the same litharge.

The means for feeding the oxidating air 8 comprise a pressure regulator 57 provided with a pressure gauge, installed downstream an electrovalve 58, and a rotameter 59 for controlling the flow rate of injected oxidating air stream.

The oxidating air is drawn from the external environment and is injected at the flexible coupling 26. Metering the amount of oxidating air flowing through the kiln is essential in order to prevent the formation of two substances which might pollute produced litharge, and namely: minium (Pb_3O_4) which is formed in the presence of an air excess, and metal lead (Pb), which is formed in case of air shortage. In particular cases, instead of environmental air suitable gas mixtures can be used.

The means 56 for controlling the depressure inside the kiln are substantially complementary to the means 8 for feeding the oxidating air.

Said means 56 comprise a suction pipe 60, a servocontrolled valve 61 for regulationg the intake, an instrument for checking the depressure inside the kiln 62 and the relevant sensor 63.

The suction pipe 60, which is installed at the end of the kiln 1 close to the second head 10, has a first, horizontal stretch branching from kiln side, and a second, vertical stretch.

In such a way, any minium formed, which precipitates owing to the cooling undergone by the dusts and the gases flowing along the pipe 60 cannot pollute the material, by now transformed into litharge, contained inside the kiln 1, but is collected inside a chamber 64 provided at the bottom end of the vertical stretch of the same suction pipe 60.

The servocontrolled valve 61 and the relevant sensor 63 maintain constantly inside the kiln 1 a preset depressure of very low value.

In fact, as it occurs for all of the apparatus handling such noxious substances as lead oxides, also these kilns are kept with an internal depression in order to prevent such oxides from diffusing through the working premises.

However, it is necessary that the value of depression is kept as low as possible, compatibly with the functional requirements of the kiln, in order to prevent the undesired and uncontrolled entering of oxidating air, which would alter the chemical reaction which governs the transformation of massicot into litharge, originating undesired byproducts, such as, e.g., minium.

The means 65 for weighing the kiln comprise a structure for supporting the kiln 66, which rests on load cells 67 suitable for detecting the weight loading the support structure 66, with the flexible coupling 26 and the sliding flange 48 being purposely provided.

The values of kiln weight are processed by an electronic control instrument (not shown in the figures) which supplies an alarm signal in case the weight of the kiln 1 exceeds certain preset values.

Said electronic control instrument can be possibly given such a structure, as to also receive the values supplied by load cells 29 and consequently adjust the revolution speed of the metering screw feeder 24 and hence the flow rate of material charged to the kiln as a function of the flow rate of material discharged through the duct 49. Furthermore, in case the current absorbed by the motor 35 is monitored, by means of said electronic system also the control can be performed of the revolution speed of the screw conveyor means 6.

The electrical kiln 1 disclosed herein is particularly suitable for producing litharge by means of the calcination of massicot; however, said kiln 1 makes it possible also other substances, even if corrosive, to be submitted to the action of heat up to a maximum temperature of 750°C and for a variable time as a function of the requirements of the process, under a controlled atmosphere, i.e., an oxidating or a reducing atmosphere, or an inert atmosphere, so as to cause suitable chemical transformation to take place in the material.

The product to be processed is stored in the feed hopper 28 from which the metering screw feeder 24 draws it as a function of the preset flowrate parameters.

The raw product enters the kiln at the first head 9, through the flexible coupling 26.

The paddles 36 of the shaft 30 push said material through the tubular body 2, inside which the material is heated up to such a temperature as to start the chemical reaction of calcination. Oxidating air supplies the necessary O_2 for free Pb contained in massicot to be oxidated to yield PbO .

The critical aspect of this process is repre-

sented by the cooling of produced litharge when the temperature thereof must decrease, starting from the temperature at which the calcination took place, to reach the room temperature, at which litharge can be regarded as stable.

Such a cooling should be as fast as possible, because the cooling curve of the material passes inside a certain temperature range (the critic range), within which litharge is converted into minium, which is a pollutant of litharge. The amount of polluting minium formed during the cooling step is substantially proportional to the stay time of litharge inside the critic range.

In the electrical kiln according to the present invention, this particular aspect was kept into particular consideration, with the heating power of the kiln being increased at the discharge region, and the number of paddles 36 being doubled in the region close to the product outlet, so that, with the revolution speed of the shaft 30 with paddles being the same, in such a region a faster and more efficacious removal of the product from the end portion of the kiln is achieved and said product is ultimately evacuated. In fact, such a region is the most critic one as to the formation of minium, and causes the greatest difficulties in the control of transformation parameters.

The differentiation of the heating power in the various regions of the kiln is obtained by varying the number of turns of the coil 11, so as to subdivide it into the elements 11A, 11B and 11C, acting with different heating powers on the respective tubular elements 13A, 13B and 13C which constitute the tubular body 13. In such a way, it is however possible to precisely establish in the kiln a prefixed constant temperature, with overheated regions (usually, the central regions) and colder regions (usually, the regions of the heads 9 and 10) being thus eliminated. In particular, also the regions close to the first head 9 and to the second head 10, tendentially colder respectively owing to the product charging and the presence of the discharge duct 49, and furthermore to the heat dispersions due to the heads 9 and 10, can anyway reach temperatures which are very close to the optimum temperature, which exists in the central region. The result is a better exploitation of the useful volume of the kiln and the control of those negative phenomena which may lead to a worsening of product quality.

The advantages shown by the kiln according to the invention are the following:

(a) The kiln is active along its whole length, and this feature made it possible its dimensions to be substantially reduced to those of just one of the tubes which compose the kilns of traditional type.

(b) The heating by means of the electromag-

netic induction effect makes it possible an excellent evenness of heating of the material to be reached, together with the possibility of establishing with considerably high precision and reliability the temperature of said material in any points of the kiln, also in case should such a result require very considerable amounts of energy to be fed along the length of the kiln.

(c) Any possible adjustments of the amount of energy fed in order to heat the kiln can be carried out very quickly.

(d) Heat dispersions are very limited, and such as not to have a negative influence of the steady-state temperature.

(e) The maintenance costs are considerably reduced, because a decrease is observed in the chemical and thermal stresses applied to the external wall of the tubes -- not lapped any longer by the particularly corrosive flue gases generated by the combustion; furthermore, the absence of free flames renders useless the presence of refractory brick linings, which, in the kilns known from the prior art, are subject to continuous checks and rebuilding operations.

(f) A possible perforation of the tube only results in the product contained in it falling down onto the underlying floor, without any dispersions of highly polluting products -- due to their lead basis -- in the surrounding atmosphere taking place.

(g) Thanks to the ease of a precise, continuous and reliable monitoring of the thermal-chemical quantities on whose basis the means for automatically regulating and monitoring the kiln work, such means can be installed easily and profitably.

(h) An environmental pollution caused by the operation of the kiln does not practically exist, in particular thanks to the control of the depressure inside the interior of the kiln, which secures that the kiln will be constantly kept at the proper depressure value.

Claims

1. Kiln (1) in particular for producing litharge by means of the calcination of massicot advancing inside the interior of the same kiln (1) under the action of screw feeder means (6), characterized in that it comprises one single tubular body (2) destined to contain the advancing material, having a major axis (3) and a first head (9) and a second head (10), means (5) for charging the raw material to the kiln installed at the first head (9), a heating unit (4) operating on the basis of the principle of electromagnetic induction acting along the length of the tubular body (2), means (8) for feeding the

oxidating air, and means (7) for discharging the material from the kiln.

2. Kiln according to claim 1, characterized in that the heating unit (4) is externally coaxial with the tubular body (2) and comprises, starting from the external surface of said tubular body, a tube of ferromagnetic material (13), at least one layer of insulating refractory material (12) and an induction coil (11).

3. Kiln according to claim 2, characterized in that the induction coil is subdivided into a plurality of elements (11A, 11B and 11C) of variable inductive power, with respect to the tube of ferromagnetic material (13), also subdivided into a plurality of elements (13A, 13B and 13C) corresponding to, and the number of which equates the number of, the elements (11A, 11B and 11C) of the induction coil (12), with each element of ferromagnetic material (13A, 13B and 13C) being linked to the adjacent element by means of joints (14) which ensure the thermal-magnetic continuity of the resulting structure.

4. Kiln according to claim 2, characterized in that between the tubular body (2) and the tube of ferromagnetic material an air space (15) is provided, inside which an inert gas is contained.

5. Kiln according to claim 4, characterized in that the tubular body (2) is made from stainless steel and the inert gas is nitrogen and can be renewed.

6. Kiln according to claim 2, characterized in that the layer of insulating refractory material (12) comprises, starting from the external surface of the kiln (1), spacer beams (19) on which the turns of the induction coil (11) rest, a coating of fiberglass-reinforced polyester resin (20), a plurality of layers of a material known on the market under the trade name "Microterm" (21), a wrapping with a fiberglass or asbestos ribbon (22) a plurality of layers of ceramic fibre (23).

7. Kiln according to claim 1, characterized in that the screw conveyor means for translating the material inside the kiln comprise a shaft (30) with paddles driven by a motor (35) and a relevant chain transmission (34), installed at a first end of said shaft (30), with the paddles (36) provided on said shaft (30) being so arranged as to form a simple screw in the region close to the first head (9) and in the intermediate region between the first head (9) and the second head (10), and to form a double screw in the region close to the second head (10).

8. Kiln according to claim 7, characterized in that the shaft (30) with paddles is supported at its ends by a first bearing (31) and a second bearing (32), which make it possible said shaft to be arranged in an out-of-alignment position, by means of an oblique shift in a direction perpendicular to the axis (3) of the kiln.

9. Kiln according to claim 1, characterized in that the shaft with paddles is associated with beating means (42) acting on said shaft simultaneously and according to such directions, and with such beating intensities as to equilibrate the blows dealt to the shaft.

10. Kiln according to claim 9, characterized in that the beating means (42) comprise three pneumatic hammers (43) acting along axes arranged at 120° relatively to one another.

11. Kiln according to claim 10, characterized in that the beating means (42) are enclosed inside a soundproofed case (54).

12. Kiln according to claim 1, characterized in that the means for feeding the raw material to the kiln (5) comprise a metering screw feeder (24) with the relevant ratiomotor (25), a feed hopper (28), a support structure (27) for said hopper, with load cells (29) being installed between said support structure (27) and said feed hopper (28), which are capable of detecting the changes in hopper (28) weight, and therefore the weight of material fed by the screw feeder (24) per unit time as a function of kiln (1) operating parameters.

13. Kiln according to claim 1, characterized in that it comprises means for feeding the oxidating air (8), with said means comprising a pressure regulator (57) equipped with a pressure gauge and installed downstream an electrovalve (58), a rotameter (59) for controlling the flow rate of oxidating air feed, with said oxidating air being injected into the kiln at the first head (9).

14. Kiln according to claim 13, characterized in that the means for feeding the oxidating air (8) operate associated with means for controlling the depression inside the kiln (56), with said means (56) comprising a suction pipe (60), a servo-controlled valve (61), and instrument for detecting the depression inside the kiln and the relevant sensor (63).

15. Kiln according to claim 14, characterized in that the intake pipe (60) has a first, horizontal stretch branching from the side of the kiln, and a second, vertical stretch, the bottom end of which is equipped with a chamber (64) for collecting the settled dusts.

16. Kiln according to claim 1, characterized in that the means for discharging the material comprise an opening (47) provided at the second head (10), a sliding coupling flange (48), and a discharge duct (49) which branches into two ducts in correspondence of a switching gate (50).

17. Kiln according to claim 1, characterized in that it comprises means (65) for weighing it, with said weighing means (65) comprising a support structure (66) which supports the kiln (1) and rests on a plurality of load cells (67) suitable for detecting the weight of said kiln (1).

18. Kiln according to claim 7, characterized in that

the motor (35) is submitted to the monitoring of the current absorbed, with said input being taken as an index of the state of risk of clogging of the material inside the kiln (1).

19. Kiln according to claim 12, 17 and 18, characterized in that the load cells (29) associated with the hopper (28) and the load cells (67) suitable for detecting the weight of the kiln (1), as well as the monitoring of the current absorbed by the motor (35) are connected with one single electronic system for controlling the raw material feed to the kiln (1).

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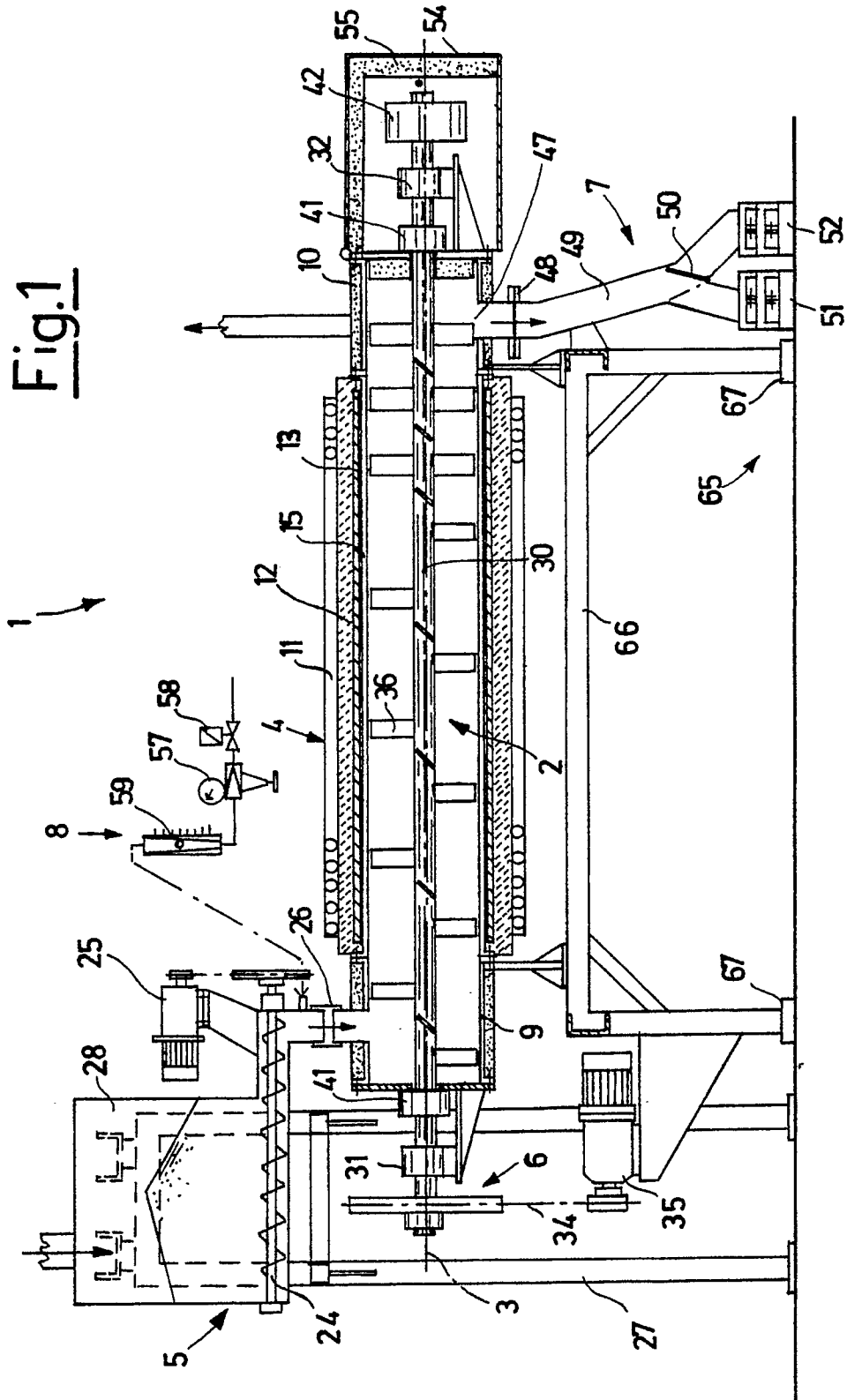


Fig.2

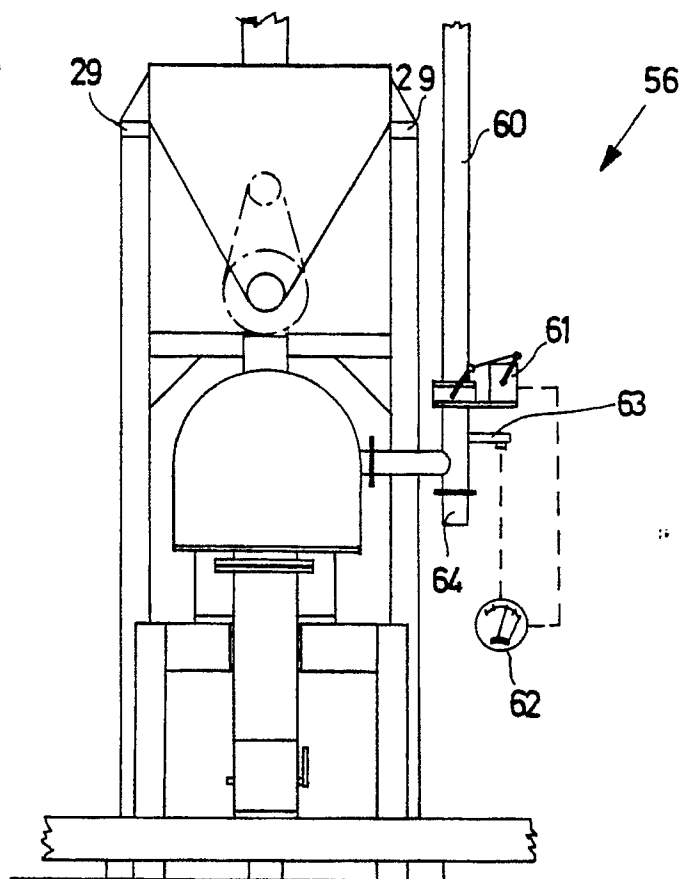
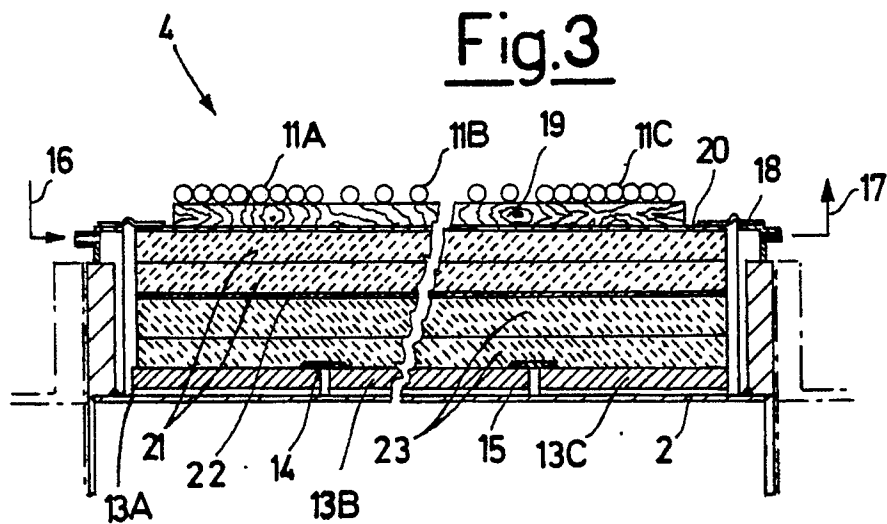


Fig.3



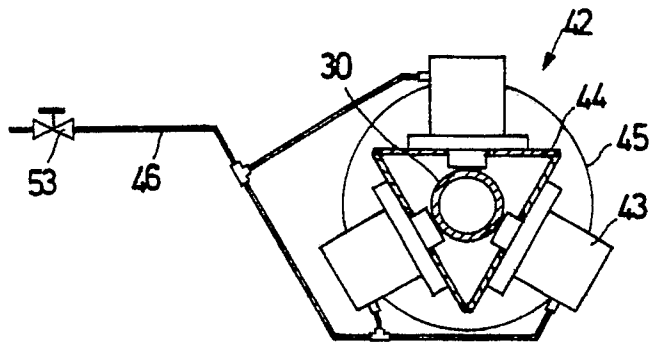


Fig.4

Fig.5

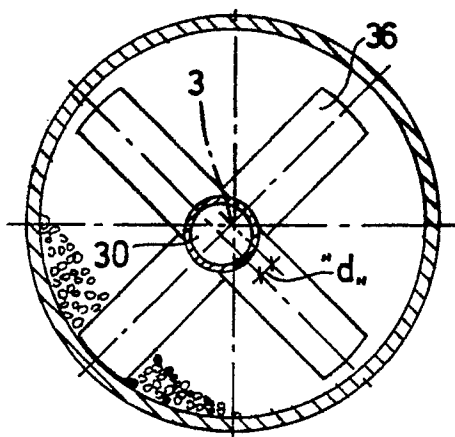
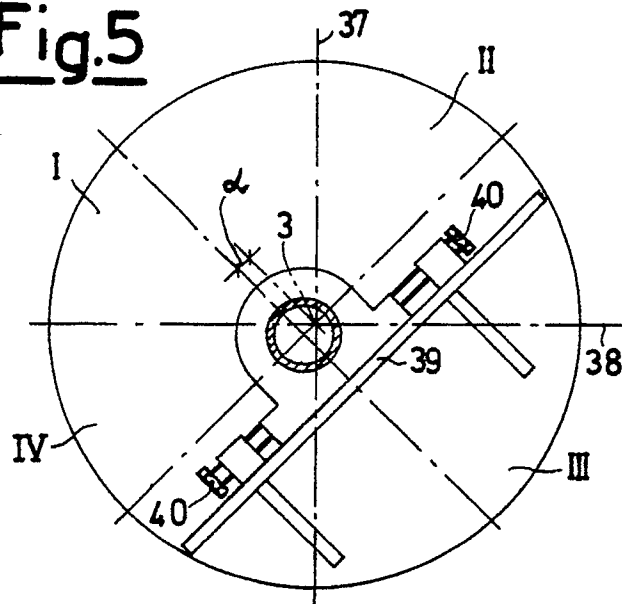


Fig.6



European
Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 90 20 1729

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
Y	WPIL/DERWENT, accession no. 84-290285(47), Derwent Publications Ltd, London, GB; & ES-A-8 405 134 (CUERVO A.P.) - - -	1	F 27 B 9/06 F 27 B 9/24 C 22 B 13/00
Y	GB-A-2 088 536 (ALCO STANDARD CORP.) * Claims; figures; page 2, lines 75-87 * - - -	1	
A		2,3,4	
A	US-A-4 606 283 (P. FARRELL) * Claims; figures * - - - - -	1	
The present search report has been drawn up for all claims			
Place of search		Date of completion of search	Examiner
The Hague		22 October 90	COULOMB J.C.
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			